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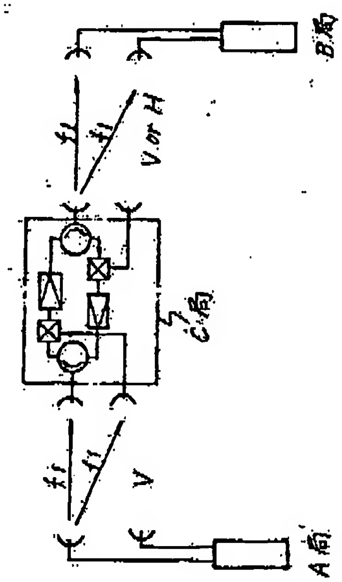
Title of invention: *supesudaibashitei* type direct repeater

Abstract: [ABSTRACT]

Application area of this repeater was magnified utilization of radio wave was planned about *supesudaibashitei* type direct repeater having a microwave synthesizer by can give direct repeater a reception diversity facility a microwave synthesizer was used, and to synthesize receiving wave and because *daibashitei* transmission gain minute lowered transmission gain of a repeater.



(Translation)

UM Appln. No. S53-109328 (Laid-open No. S55-26935 - Ref.5)
Filed August 8, 1978;
Laid-open February 1980

Specification

1. Title of Device

Space diversity type direct-point repeater device

2. Scope of Claim for Utility Model Registration

A space diversity type direct-point repeater device including means for receiving high-frequency signals and amplifying means for amplifying said high-frequency signals directly without any conversion therefrom into their intermediate-frequency signals or their baseband signals, characterized in that said high-frequency signal receiving means is comprised of a space diversity receiver device.

3. Detailed Description of the Invention

This invention relates to a space diversity type direct-point repeater having a microwave combiner.

Conventionally, a microwave direct-point repeater system mainly comprises a passive repeater which utilizes reflectors, parabolic-antenna back-to-back connection or the like. To realize high reliability of radio channels, need has arisen for using huge reflectors for a reflector-based repeater channels. However, recent developments in radio wave propagation has made it clear that, when fading occurs, the angle of the incidence of microwave onto a reflector fluctuates significantly because of irregular changes in terrestrial refractive index. In addition, a huge reflector has extremely sharpened directivity. For example, in a 6.7GHz band square 10m x 10m reflector, a first null point appears at about fourteen minutes and a second null point appears at twenty-eight minutes. Therefore, a channel break occurs when cutting across the first null point and, if staying on the first null point, stops dead for a long

tract of time. A reflector having a diamond shape, an onion-flake shape, a rectangular shape, a curved shape, or the like, is known as a reflector with wide directivity for solving the above problem, but the directivity is not wider than that of a parabolic antenna. On the other hand, a parabolic-antenna back-to-back connection approach is of limited application because an antenna efficiency of each parabolic antenna is low in comparison with a reflector, although fluctuation of the angle of incidence, which causes the above problem in case of the reflector-based repeater, presents no problem because of wide directivity of each parabolic antenna. To overcome the shortcoming of the reflector-based approach and the parabolic-antenna back-to-back connection approach, a direct-point repeater device is used which is a combination of the parabolic-antenna back-to-back connection approach and a microwave direct-point amplifier. Because the direct-point repeater is not susceptible to fluctuation of the angle of incidence and is obtainable by easily modifying the already-developed huge-reflector based repeater without any changes on its frequency configuration, the approach is effective. However, the direct-point repeater approach must use, for a duct type fading, a space diversity system identifying each route by means of V-H complex polarized electromagnetic radiation or different frequencies, like the reflection-based approach. Therefore, effective use of radio waves cannot be achieved.

This invention is aimed at improving the disadvantages of the aforementioned reflection-based passive repeater device or the foregoing direct-point repeater device and is embodied in a space diversity type direct-point repeater device, in which effective use of radio waves can be achieved by letting the direct-point repeater device have a reception diversity function to combine received wave signals by the use of microwave combiners, and the usable range of the present repeater device is expanded by lowering the gain of the repeater by a diversity gain.

Referring to the drawings, the present invention will now be explained in detail.

Fig. 1 is a block diagram of a conventional space diversity system, wherein A station is a transmitter, C station is a repeater, B station is a receiver, and the C station is provided with a

direct-point repeater device. In the figure, for the purpose of the route identification, the A station transmits radio wave signals of vertically polarized waves and horizontally polarized waves (V-H polarization) or frequencies f_1, f_3, the C station relays or retransmits them with the same V-H polarization or frequencies f_1, f_3, and the B station receives them. Turning to another event where the B station and the A station are transmitter and receiver, respectively, a similar system is constituted with frequencies f_2, f_4.

In this connection, the repeater C for V-H polarization has, for example, a structure illustrated in a block diagram of Fig. 2. For example, the V-polarized wave signal transmitted from the A station is received at an antenna 1 of the C station, passes on a circulator 3, is amplified at an amplifier 7, further passes on a circulator 4, and is retransmitted as the V-polarized wave signals from an antenna 2. On the other hand, the H-polarized wave signal received at the antenna 2 passes on a circulator 5, is amplified at an amplifier 10, further passes on a circulator 6, and is retransmitted from the antenna 1.

Fig. 3 is a block diagram of an embodiment of the present invention, wherein a C station is a space diversity type direct-point repeater device according to the present invention. This figure shows, similarly to Fig. 1, an event where the A station is a transmitter and the B station is a receiver. In the illustration, the relationship of used frequencies is different from, for example, that of Fig. 1 using frequencies f_1, f_3, and its receiver system can be constituted as a space diversity type by using one frequency/one polarization. If a DU ratio to be described below cannot be obtained suitably because of the environment around the station, two polarizations may be used in one of the sections and can be made to cross each other. Thus, its application can be widened. This is impossible in accordance with the embodiment of Fig. 1, wherein the route identification is realized by the V-H polarization.

Fig. 4 is a block diagram of an embodiment of a repeater station according to the present invention. In the figure, "11", "12" denote a main antenna and a sub-antenna, respectively, both of which face the A station of Fig. 3 (frequency f_1). The signals received at these

antennas pass through feeder lines and are connected to input terminals 13, 14 of the present device. The input terminal 13 also serves as a transmission output terminal for the A station. The input power signal for the terminal 13 passes through the circulator 3, which is a unit common to transmission/reception, and is subjected to a removal process of interference wave noises due to neighboring channels or the like by the use of a band-pass filter BPF_1 21 of center frequency f_1 and is then connected to a microwave combiner 23, which is comprised of a magic tee or the like. On the other hand, the input power signal received at the sub-antenna 12 passes through the input terminal 14 and a band-pass filter BPF_1 22 and is connected to the microwave combiner 23. The microwave combiner 23 combines the received signals of the main antenna 11 and the sub-antenna 12, while controlling the signals so that they have the same phase. The microwave combiner needs an automatic phase shifter to provide a precise agreement between phases of two signals of the main antenna and the sub-antenna at their combination point, but explanation thereof will be omitted here because it has no direct relation to the present invention.

The received signal combined at the microwave combiner 23 as such is frequency-shifted by a predetermined valve (e.g., 200 MHz) and amplified directly by the microwave amplifier 7 so as to have a desired level required for the channel. Its output passes a band-pass filter BPF_2 24, which has a frequency f_1 equal to that of the band-pass filter for the input signals, for the removal of undesired wave noises therefrom, and also passes through the circulator 4, and is then connected to a transmission output terminal 15. It is further connected from the transmission output terminal 15 through a feeder line to a transmission antenna 17 and is transmitted from the antenna 17 toward the B station. The antenna 17 also receives a transmission wave signal (frequency f_2) of the B station, and the terminal 15 also serves as an input terminal, wherein the signal passes through the circulator 4 and is subjected to the removal process of interference wave noises by the use of the band-pass filter 25 (BPF_3) having a center frequency f_2 and is then connected to a microwave combiner 26. On the other hand, the received signal of the transmission wave signal from the B station, which is

received at an antenna as a sub-antenna of the main antenna 17, passes through a feeder line and an input terminal 16 and is subjected to the removal process of interference wave noises at a band-pass filter 27 (BPF_3) and is connected to the microwave combiner 26, with a result that the power signals received at the main antenna and the sub-antenna are combined by the combiner 26. Subsequently, in a similar way, the signal is amplified by the microwave amplifier 8 and passes through a band-pass filter 28 (BPF_4) of a center frequency f_2 and the circulator 3 as well as the terminal and a feeder line and is then transmitted through the antenna 11 toward the A station. Thus, the repeater device can provide a two-way communication. In addition, the transmission frequencies of the A and the B stations have the difference of about 150 MHz therebetween.

According to the present invention, the received signals at the main antenna and the sub-antenna are subjected to the microwave combination. Therefore, the result can be made higher than the reception power received at a single antenna. The above-described present invention uses the microwave combination to achieve the best channel reliability and the best channel quality simultaneously, but, if channel reliability is to be addressed, the system having microwave switchers as substitutes for the microwave combiners works as well as the original one. However, as well known, a microwave combiner generally has a channel reliability twice as high as a microwave switcher. In addition, if the vertical interval between the main antenna and the sub-antenna of the present invention is selected suitably, its space correlation coefficient can be made small. Furthermore, the space diversity gain obtained in the above manner can be assigned to the amplification gain at the direct-point repeater, with a result that the direct-point repeater has to have only a small desired amplification gain. In this case, the desired wave to undesired wave ratio (DU ratio) can be enhanced.

The DU ratio affects interference noises (long echo noises due to diffraction of transmission/reception waves). Also, in case where the repeater does not modify its frequency configuration like the present invention, the DU ratio is determined by the degree of coupling at the transmission/reception antenna and the amplification gain at the repeater device. For example, in case where the degree

of antenna coupling is E (dB) and the amplification gain of the repeater device is G (dB) and where the feeder lengths for transmission and reception are equal to one another, the DU ratio of the desired wave 30 and the interference wave 31 in the schematic diagram of Fig. 5 meets the following equation: D/U = E - G. The area of application of the present system, which is determined by the interference noises allowable for the channels and, becomes broader as the DU ratio becomes large. To increase the DU ratio, the degree of antenna coupling may be increased. However, there is a limitation to it. The other way is to increase the amplification gain of the direct-point repeater in consideration of high reliability channels. The present invention solves the mutually contradictory requirements with a space diversity technique, with the microwave combiner achieving the effective use of radio wave.

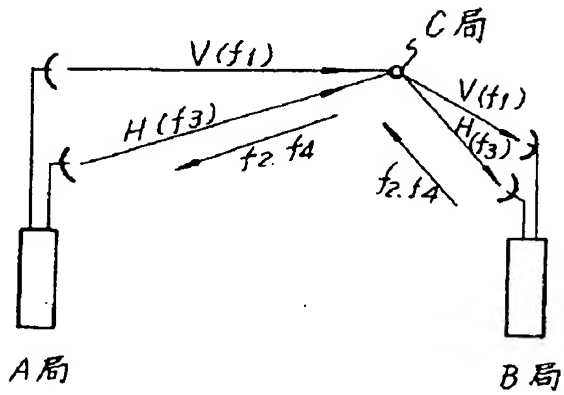
Fig. 6 is a block diagram of another embodiment of the present invention showing a structure in which the space diversity technique is not used on one of sections shown in Fig. 3 and in which the part enclosed by dotted chain line in Fig. 4 is not needed for simplicity. The DU ratio for this case is shown in a schematic diagram of Fig. 7.

In addition, in case where there are two reflector-based repeaters and where they are positioned near to the A station and the B station, respectively, so that the conventional approach (the reflector-based approach or the direct-point repeater approach) cannot use the space diversity approach, easy improvement can be achieved without any changes of the current frequency configuration by constituting, with the embodiment of Fig. 6, the system where the distance between the repeater stations C is longer than the distance between the A station and the C station and the distance between the B station and the C station.

As explained above, for channels for which the space diversity technique cannot be used normally, the present repeater device can improve the reliability and the quality of the channels with the current frequency configuration so that it broadens the area of application and makes effective use of radio frequencies.

4. Brief Description of the Drawings

Fig. 1 is a schematic view of a conventional repeater system; Fig. 2 is a block diagram of a conventional direct-point repeater device; Fig. 3 is a schematic diagram of a repeater system in accordance with the present invention; Fig. 4 is a block diagram of the direct-point repeater device according to the present invention; Fig. 5 is for the explanation of the DU ratio according to the present invention; Fig. 6 is a block diagram of another embodiment of the present invention; Fig. 7 is for the explanation of the DU ratio of Fig. 6; and Fig. 8 is a schematic view of the repeater system with the embodiment of Fig. 6. In the drawings, reference numeral 1, 2, 11, 12, 17, 18 denote antennas; 3, 4, 5, 6, circulators; 7, 8, 9, 10, microwave amplifiers; 13, 14, 15, 16, input/output terminals; 21, 22, 24, 25, 27, 28, band-pass filters; 23, 26, microwave combiners; 30, a desired wave; and 31, interference wave (undesired wave).



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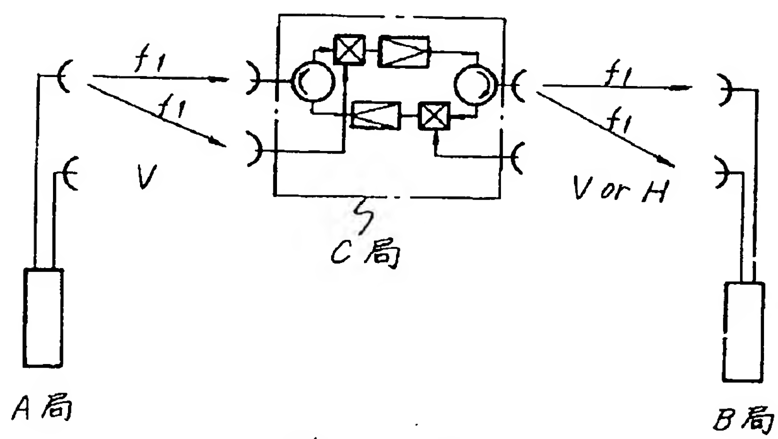

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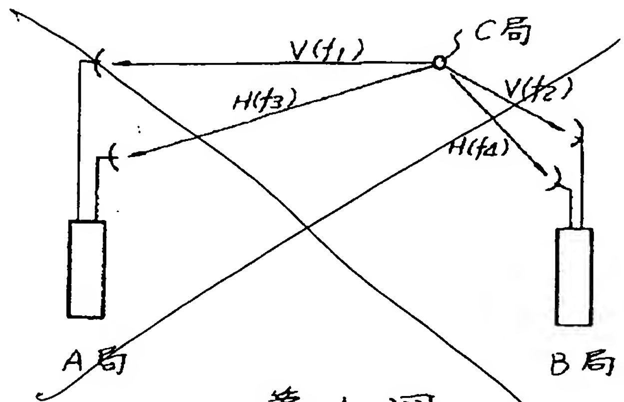
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V(f1)
H(f3)
V(f2)
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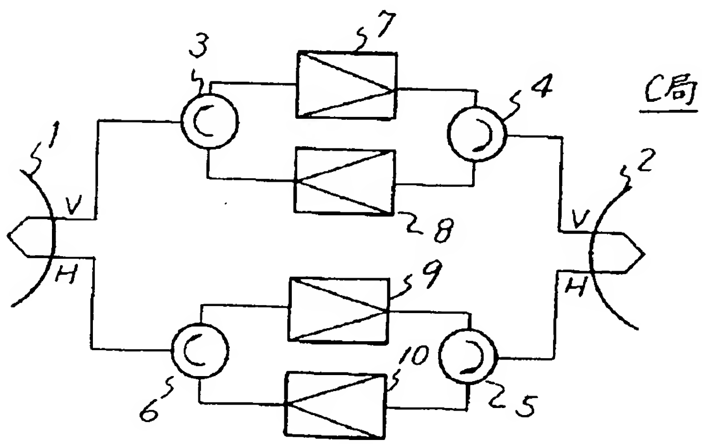
A局
B局

第 1 図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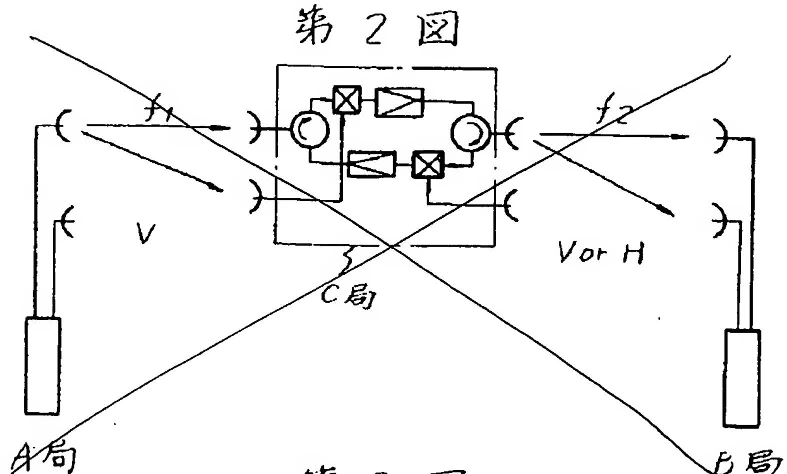
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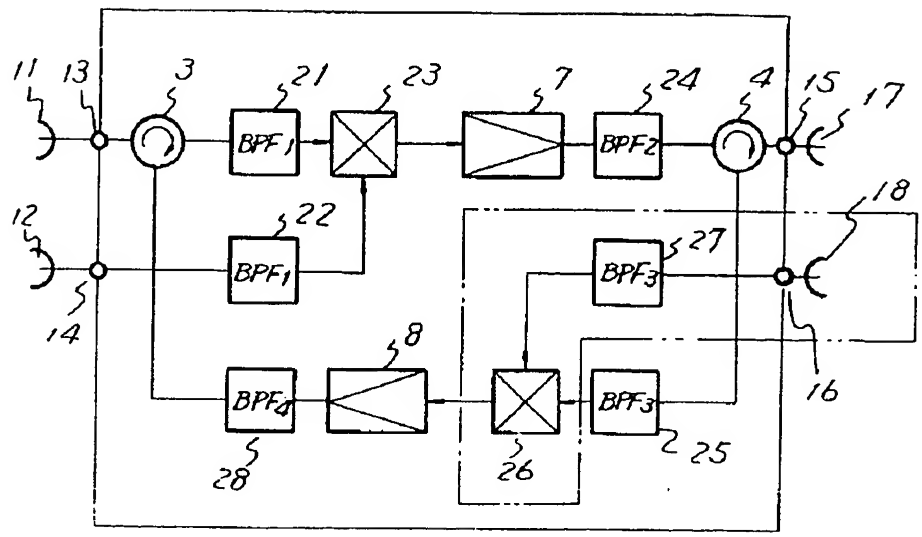

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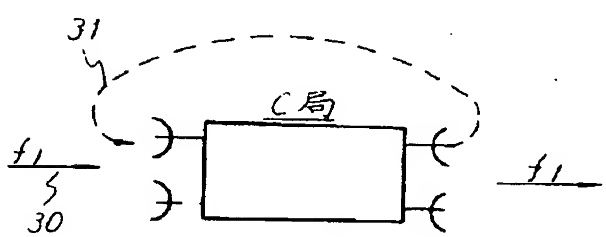

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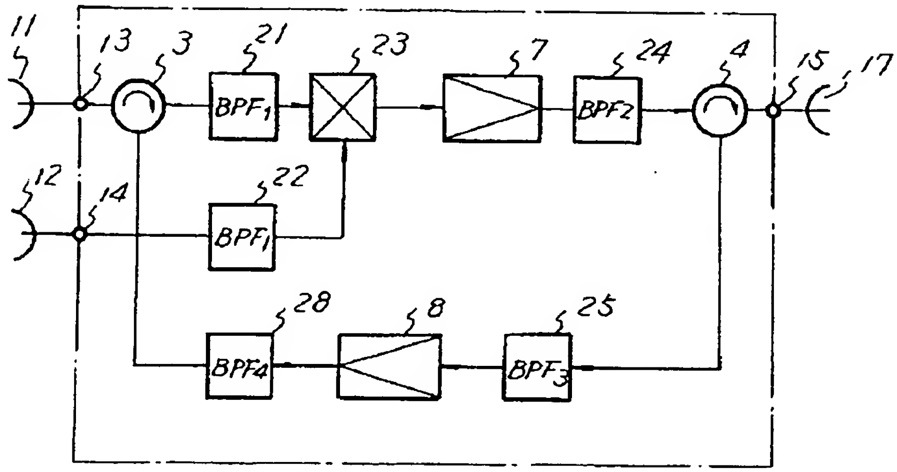

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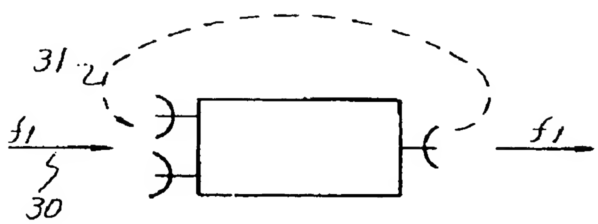
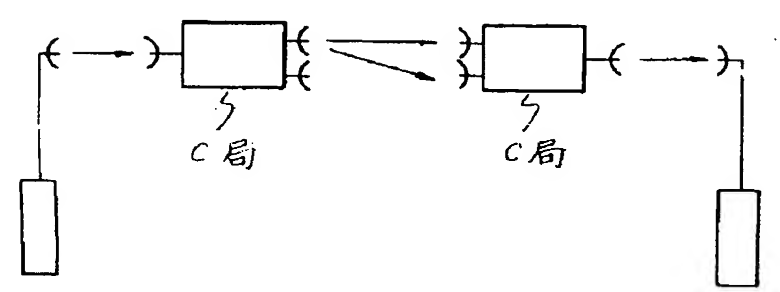


第 7 図



第 8 図

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